

PATENT SPECIFICATION

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(54) METHODS OF AND APPARATUS FOR CONTINUOUSLY DEFORMING WORKPIECES OF EXTENDED LENGTH

(71) We, WESTERN ELECTRIC COMPANY, INCORPORATED of 222 (formerly 195) Broadway, New York City, New York State, United States of America, a Corporation organized and existing under the laws of the State of New York, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to apparatus and methods for deforming an elongated workpiece to form an elongated product. As an example, apparatus and methods according to the invention may be used for continuously extruding a rod of unrestricted length to produce a wire of unrestricted length.

In our British Patent Specification 1,400,874, there is described apparatus and methods for the continuous steady extrusion of a workpiece of unrestricted length through a deforming agency, wherein several moving trains of gripping elements apply pressure to the workpiece and advance it through the deforming agency, preferably, while building up stress in the workpiece, from a station upstream of the deforming agency to the deforming agency.

The present invention relates to apparatus and methods utilising this type of workpiece transport for forming the workpiece against a deforming agency, for example, an extrusion die.

According to one aspect, the invention provides an apparatus for continuously deforming an elongated workpiece to produce an elongated product comprising a deforming means, a plurality of trains of gripping element members each arranged to move in an endless path and means for driving them around said paths the paths being arranged so that members of each train come together at a first station to form a gripping element and continue together to a second station, the deforming means being located between the

first and second stations, the inner surfaces of the gripping element members defining between them a central chamber in said gripping elements between said first and second stations for containing the workpiece, a plurality of endless belts each associated with a different one of the trains of gripping element members and arranged to advance in contact with the outer surface of its associated member from the first station to the second station and means for applying pressure through the belts to the gripping element members to produce stress in a workpiece within the said chamber so that the moving elements continuously advance the workpiece and force the workpiece into contact with the deforming means.

According to another aspect, the invention provides a method of continuously deforming an elongated workpiece to produce an elongated product comprising driving a plurality of trains of gripping element members along endless paths so arranged that a gripping element member from each train comes together at a first station to form a gripping element and continue together to a second station, an inner surface of each of the gripping element members defining between them a chamber running between the first and second stations, advancing in an endless belt in contact with an outer surface of each of the gripping element members of a train between the first and second stations, applying pressure through the associated belt to each gripping element member between the first and second stations so as to force the members towards each other and thus apply stress to a workpiece contained within the chamber, whereby the workpiece is gripped and continuously advanced against a deforming means located within the chamber between the first and second stations to produce the elongated product.

Such apparatus may include facilities for engaging the gripping element members of two adjacent trains of gripping element members with a common driving mechanism, e.g.,

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by virtue of a common drive gear engaging simultaneously sets of teeth on neighbouring gripping element members, in order that the gripping element members may be driven in unison without any tendency for one of the gripping element members to lag another. The mechanisms, further, may include a number of guide elements which extend along the paths of the advancing gripping element members and which each engage simultaneously portions of two adjacent gripping elements to guide the engaged gripping element members during their advance.

The invention will be described in more detail as embodied in our extrusion apparatus and method.

In the drawings:

FIG. 1 is an isometric view, with parts broken away, illustrating apparatus in accordance with the invention for continuously extruding rod into wire;

FIG. 2 is a partially diagrammatic view in elevation showing certain elements located at the left or exit end of the apparatus of FIG. 1;

FIG. 3 is a diagrammatic view in perspective depicting the paths of four gripping element members and belts in relation to the rod and to an extrusion die;

FIG. 4 represents a longitudinal view, partially in section and partially diagrammatic, of the apparatus of FIG. 1, with certain features, e.g., pinion gears, omitted for the purpose of clarity;

FIG. 5 is an enlarged transverse section through a portion of the apparatus;

FIG. 6 is an enlarged, fragmentary, isometric view, showing the gripping element members surrounding and engaging the rod, portions of pressure pads and of the belts adjacent the exterior surfaces of the gripping element members, and the die and die stem, this figure being rotated 45° relative to FIG. 1 to show certain details more clearly.

FIG. 7 is a longitudinal section through a sizing and waxing assembly located at the right or entrance end of the apparatus of FIG. 1;

FIG. 8 is a plan view of an inner face of a pressure pad including seals associated therewith;

FIG. 9 is a plan view of the outer face of the pressure pad of FIG. 8, showing cooling channels associated with such outer face;

FIG. 10 is a transverse sectional view of the pressure pad taken along the line 10—10 of FIG. 9; and

FIG. 11 is a transverse sectional view of an alternative pressure pad.

Referring initially to FIG. 1, the apparatus 10 may be utilized for the continuous and steady extrusion of an elongated workpiece of indefinite (i.e., unrestricted) length, such as rod 11, to form an elongated product, like-

wise of indefinite (i.e., unrestricted) length, such as wire 12.

Referring now also to FIGS. 3 to 6, the extrusion apparatus 10 is seen, generally, as comprising four groups or trains of gripping element members 13, in this case, quadrants. The gripping element quadrants of each train are adapted to be driven by a number of pinion gears 14 around an endless path 16 defined in part by straight lengths 17 and curved sections 18 of track. The paths of the four trains of gripping element quadrants 13 converge about the rod 11 emerging from a sizing and waxing assembly 19 (FIG. 4) at the entrance 20 of the apparatus 10 forming a first station, so that successive sets of four gripping element quadrants, one from each train, cooperate to form a succession of gripping elements 21 (FIGS. 3 and 6) encircling successive portions of the surface of the waxed rod. The gripping elements 21 are adapted to function, in a manner which will hereinafter be described, to advance the waxed rod 11 in the "X" direction to the deforming agency, in this case an extrusion die 22 having a die stem 23, with the wire 12 resulting from such extrusion operation appearing at an exit of the apparatus 10, and the cooperating gripping element quadrants 13 diverging at a second station 24 past (i.e., downstream of) the extrusion die 22 and proceeding along their respective endless paths 16. It will be seen, further that the inner surfaces 49' of the succession of gripping elements 21 between the first station 20 and the second station 24 constitute a pressure chamber having, in effect, endless moving walls advancing with the length of the rod in the apparatus.

Referring to FIGS. 1, 5 and 6, the apparatus 10 will next be described in greater detail. A block 26 is provided with a generally square, central aperture 27 extending longitudinally thereof along the X direction from the entrance at first station 20 to the exit at second station 24 of the apparatus. The aperture 27 is bordered, for the most part, by two flat, parallel, opposed walls 28 and two flat, parallel, opposed walls 29.

Four hydraulic motors 31, preferably coupled to be driven in unison from a common supply of pressurized motive fluid (not shown) are mounted on the block 26 in a common plane, perpendicular to the X direction, adjacent to the entrance of the apparatus 10. Several additional sets of four hydraulic motors each, e.g., 32, 33, 34, preferably also coupled to be driven in unison from the common supply of pressurized motive fluid (not shown), are mounted on the block 26 in parallel planes, each perpendicular to the X direction, adjacent to the motors 31. Four more hydraulic motors 35, preferably also coupled to be driven in unison from the

common supply of pressurized motive fluid (not shown), are mounted on the block 26 in a common plane, perpendicular to the X direction, adjacent to the exit of the apparatus. The various hydraulic motors 31, 32, 33, 34, 35 are preferably reversible, so as to be usable as pumps where appropriate. Each hydraulic motor 31, 32, 33, 34 or 35 has an output shaft 36 (FIG. 5) rotatably mounted in bearings 37 positioned in a bore 38 formed in the block 26. Each shaft 36 has mounted thereon one of the pinion gears 14, the teeth of which extend into the central aperture 27 at the junction 39 of adjacent walls 28 and 29.

As may be seen in FIGS. 3, 5 and 6, each gripping element portion 13 takes the form of a prism with the approximate cross-sectional shape of a quadrant, in a Y-Z plane perpendicular to the X direction, having equal sides 41 and 42 terminating in a channel 49', and a base 43. Each gripping element 21 is formed by four such gripping element quadrants, one from each train of quadrants, which are brought together along adjacent sides 41 and 42. With the four gripping element quadrants 13 so converged to form a gripping element 21, the channels 49' combine to form an aperture 44 extending through the centre of the gripping element perpendicularly to the Y-Z plane. The size and configuration of the central aperture 44 correspond closely to the size and configuration of the waxed rod 11.

Land areas 45 are preferably formed on each gripping element quadrant 13 in the region surrounding the central aperture 44. These land areas provide for intimate contact between successive gripping elements 21 about the waxed rod 11, while providing a contact area of limited size in order that any high-pressure fluid which might leak into the contact area might exert only a limited force tending to separate the successive gripping elements along the X direction.

Along each corner of each gripping element quadrant 13 other than at the central aperture 44, i.e., along each corner where a side 41 or 42 joins the base 43, a succession of teeth 46 extends perpendicularly to the Y-Z plane. The lateral span of each tooth 46 is approximately one-half the width of the teeth of the pinion gears 14. As is illustrated in FIGS. 5 and 6, the arrangement is such that the succession of teeth 46 located along a side 41 of one gripping element quadrant 13 and the succession of teeth 46 located along the mating side 42 of an adjacent gripping element quadrant 13 lie in a side-by-side relationship. The teeth 46 at the neighbouring corners of the two adjacent gripping element quadrants 13 are to be contacted simultaneously and driven in unison by a common pinion gear 14, the pinion gear acting to key the quadrants together during their advance

through the aperture 27 within the block 26 so as to prevent either of the quadrants from lagging the other during such advance. Additional hydraulic motors and pinion gears may be employed to drive the four trains of gripping element quadrants 13 along the straight lengths 17 and/or the curved sections 18 of track outside of the block 26, while suitable scrapers for degreasing the gripping element quadrants may also be located conveniently along the straight lengths 17 of track.

Four, preferably square, apertures 47 extend through each gripping element 21 perpendicularly to the Y-Z plane in locations slightly radially inward toward the central aperture 44 from the teeth 46. Each square aperture 47 is formed by two facing "V"-shaped grooves, one in each side of a pair of adjacent gripping element quadrant sides 41 and 42. The square apertures 47 are dimensioned to correspond closely to the outer dimensions of four guide elements 48, which extend in the X direction through the aperture 27 in the block 26 between the entrance end and the exit end of the apparatus 10, such that the precise orientation and location of the gripping elements 21 will be fixed, during their traverse through the aperture 27, by the guide elements 48. Additional guide elements 49 (FIGS. 2 and 4) are adapted to cooperate with the straight lengths 17 and curved sections 18 of track to guide the various gripping element quadrants 13 along the endless paths 16 externally of the block 26 interacting with the "V"-shaped grooves along the quadrant sides 41 and 42.

Four pressure pads 51 (FIG. 6) extend along the walls 28 and 29 of the aperture 27 within the block 26, radially outwardly from the gripping element quadrants, from the entrance to the exit of the apparatus 10. Each pressure pad 51 extends laterally across an entire wall 28 or 29 between neighbouring junction areas 39. A number of cooling channels 52 (FIG. 9) extend along an outer face 53 of the pressure pad adjacent to the associated wall 28 or 29 and are adapted for the circulation of a coolant from a source (not shown). A seal assembly 54 (FIG. 8) is located along an inner face 56 of the pressure pad. The seal assembly 54 may be seen to include a number of inner seals 57 surrounded by an outer seal 58.

Four endless belts 59 (FIGS. 3 and 6) extend through the aperture 27 in the block 26 along the inner faces 56 of the pressure pads 51. The endless belts are composed of a material, such as a steel alloy, capable of withstanding high pressures, temperatures and friction forces. Each belt 59 extends in the X direction along successive base portions 43 of one train of gripping element quadrants 13 and preferably covers substantially the entire lateral span between the teeth 46 adjacent to the sides 41 and 42 of each quad-

rant in the train. The arrangement is such that four belts 59 will be driven by frictional engagement with the gripping element quadrants 13, each travelling about an endless path, generally following one of the four endless paths 16 of the gripping element quadrants 13, but preferably separated from such endless path 16 along a portion thereof, exterior to the block 26, so as to permit enhanced cooling of both the belt and the associated gripping element quadrant. The endless belts 59 serve to transmit gripping pressure from the stationary pressure pads 51 to the moving gripping element quadrants 13 as the belts advance with the quadrants through the block 26. The belts 59 provide readily replaceable wear surfaces intermediate the pressure pads and the gripping element quadrants. Suitable mechanisms for waxing the belts 59 may be incorporated along any convenient portion of the paths of the belts, e.g., in the area of the straight lengths 17 of track.

Gripping pressure may be provided to the endless belts by means of a high pressure fluid, e.g., a grease transmitted from a source (not shown) through a number of passageways 61 (FIG. 6) within the block 26 and a number of additional passageways 62 (FIGS. 8 and 10) through the pressure pads 51 which communicate with the seal assemblies 54, the coolant and the high-pressure fluid being kept separated by conventional seals. The arrangement is preferably such that the fluid pressure increases within each successive passageway 62 and each successive inner seal 57 in the X direction from the entrance end of the apparatus 10 toward the exit end, i.e., in the direction of travel of the waxed rod 11. The outer seals 58 have been found advantageous in providing an intermediate pressure zone between the various inner seals 57 and the area surrounding the seal assemblies 54, reducing any tendency toward leakage of the high pressure fluid.

An alternative seal arrangement, shown in FIG. 11 of the drawing, also useable with the apparatus of the invention, includes additional seal assemblies along the outer faces 53 of the pressure pads 51. Internal coolant passageways 52' replace the cooling channels 52. The arrangement is such that additional seals 58' on the outer faces 53 of the pressure pads 51 surround larger areas than do the seals 58 on the inner faces 56. As a result, the pressure pads are biased radially inwardly into firm engagement with the gripping element quadrants 13 upon introduction of high pressure fluid into the passageways 61 and 62. This will cause the pressure pads 51 to press at their edges against the edges of the teeth 46 on the gripping element quadrants 13, thereby preventing any tilting or rocking of the quadrants about the axis of the rod 11.

It is known in the art that many metals and other materials increase in ductility, or have an increased capacity for deformation without fracture, when they are subjected to high pressure. This effect is known as the "Bridgman Effect", and the principle is treated in "Large Plastic Flow and Fracture" by P. W. Bridgman, published by McGraw Hill (New York, 1952). The present invention is particularly adapted to subject the rod 11 to such high pressures. For example, when the rod 11 is of aluminium, the apparatus 10 may be designed so that pressure on the rod 11 adjacent to the die 22 will be approximately 150,000 psi, and where the rod 11 is of copper, the apparatus 10 may be designed so that pressure on the rod 11 adjacent to the die 22 will be approximately 250,000 psi. These pressures are far above the respective yield strengths of aluminium and copper and will increase the ductility, or capacity for deformation without fracture, of these materials.

Referring now to FIG. 7 of the drawing, the sizing and waxing assembly 19 includes a sizing die 63 located upstream of a waxing chamber 64. A suitable shear transmitting medium 66 is continually introduced from a source (not shown) into the chamber 64. The shear transmitting medium which may be utilized in practising the present invention will desirably have a high viscosity and shear strength, be capable of lubricating the dies 22 and 63, provide good wetting action on the rod 11, and have minimal viscosity variation with respect to pressure, temperature and shearing rate. Such a medium may otherwise be known as viscous fluid, and examples of such a suitable medium are beeswax and polyethylene wax. Accordingly, the term "wax" is used herein to represent any such shear transmitting medium.

Also forming parts of the sizing and waxing assembly are a scraper 67 at the entrance to the assembly 19, a wiper 68 for removing excess wax from the rod 12 downstream of the waxing chamber 64 and associated housing and supporting structures. A number of channels 69 extend through the sizing die 63 from the waxing chamber 64 to a small entry chamber 71 in order to provide a lubricating coating of the wax 66 on the rod during the initial sizing of the rod.

In the operation of the apparatus previously described and in carrying out the method of the invention, an initial length of the rod 11, preferably of reduced radius to facilitate passage through the dies 22 and 63, is first fed, e.g., manually, along the X direction from a source (not shown) into the sizing and waxing assembly 19, then into the aperture 27 within the block 26, and there into the region where the four trains of gripping element quadrants 13 converge to form the gripping elements 21. In its passage through

the waxing chamber 64, the initial length of row will have acquired a coating of the wax 66.

Once the initial length of the rod has been inserted for a sufficient distance into the central aperture 44 between several of the gripping elements, the various hydraulic motors 31, 32, 34 and 35 are energized in order to rotate the associated pinion gears 14. It is considered advantageous that certain of the motors, such as the motors 35, be reversed, so as to operate as pumps, in order to maintain a sufficient back pressure downstream of the die 22 to clamp the gripping element quadrants 13 of each train together along the X direction so as to prevent leakage of the wax 66 between the quadrants. Such reversal of the motors 35 may conveniently involve interconnecting the reversed motors 35 with certain of the motors 31, 32, 33 or 34, such that the reversed motors 35 will serve to drive, or assist in the driving of, the associated motors 31, 32, 33 or 34.

The four trains of gripping element quadrants 13 are advanced along the endless paths 16 by the rotating pinion gears 14, with the gripping elements 21 which surround the waxed rod 11 tending to grip and pull the waxed rod along with their advance in the X direction. The gripping elements are guided during such advance by the interaction between the guide elements 48 and the walls of the apertures 47. The rate of travel of the various trains of gripping element quadrants 13 through the block 26 is maintained uniform due to the keying action provided by each pinion gear 14 acting on the teeth 46 along the adjacent outer peripheries of two neighbouring gripping element quadrants. Thus, any tendency for one of the quadrants to lag the others within the aperture 27 in the block 26 is avoided.

As each new element of the rod 11 advances in the X direction to the entrance end of the apparatus 10, it first encounters the scraper 67 (FIG. 7) in entering the sizing and waxing assembly 19. The scraper serves to remove surface material, such as dust and dirt, from the advancing rod element. The rod element then acquires an initial wax coating in the small entry chamber 71, incurs an initial reduction in size in passing through the sizing die 63, is rewaxed in the waxing chamber 64, and finally has its wax coating reduced to a desired thickness by the wiper 68 as the rod element exits from the sizing and waxing assembly 19 and enters the central aperture 27 in the block 26. The size and configuration of the waxed element of the rod 11 now correspond closely to the size and configuration of the central aperture 44 which extends in the X direction through the centre of the converged gripping elements 21.

The element of the rod 11 next advances into the region where the four trains of grip-

ping element quadrants 13 converge. A set of four advancing quadrants comes together to form a gripping element 21 surrounding the waxed rod element. The four belts 59, meanwhile, contact the bases 43 of the four gripping element quadrants 13 which form the gripping element 21, advancing by virtue of frictional contact with the quadrants, and serving to transmit gripping pressure to the quadrants from the four stationary pressure pads 51. Shear forces in the X direction are transmitted to the rod element to cause the rod element to continue to advance with the gripping element toward the die 22. At the same time, radial compressive forces applied by the gripping element quadrants 13 increase with X direction movement of the gripping elements due to the increasing fluid pressure level maintained within each successive passageway 62 and each successive inner seal 57 of the seal assemblies 54 on the pressure pads 51. Thus, the pressure applied through the wax coating on the rod element builds up to a sufficient level upstream of the die 22 to increase the ductility of the rod element substantially, whereupon the rod element is caused to pass through the die 22 and is hydrostatically extruded into an element of the wire 12. The gripping element 21 associated with the wire element so produced continues to advance about the advancing wire element to a location somewhat downstream of the die 22. At this point, the four component gripping element quadrants 13 diverge, each to follow its own endless path 16 back toward the entrance end of the apparatus 10, and there to recombine with the other three quadrants to receive an additional element of the advancing rod 11.

It is to be understood that the described apparatus and methods are simply illustrative of a preferred embodiment of the invention. It should be clear that various other embodiments might also be utilized for extruding or otherwise deforming rod or any other elongated workpiece of circular or other cross section in accordance with the principles of the invention. For example, alternative embodiments might incorporate fewer or more than four trains of gripping element members which travel about endless paths and which cooperate to form gripping elements for advancing an elongated workpiece of indefinite length to be deformed into an elongated product of indefinite length. Many other modifications might also be made within the scope of the invention.

WHAT WE CLAIM IS:—

1. Apparatus for continuously deforming an elongated workpiece to produce an elongated product comprising a deforming means, a plurality of trains of gripping element members each arranged to move in an endless path, and means for driving them around



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the waxing chamber 64, the initial length of row will have acquired a coating of the wax 66.

Once the initial length of the rod has been inserted for a sufficient distance into the central aperture 44 between several of the gripping elements, the various hydraulic motors 31, 32, 34 and 35 are energized in order to rotate the associated pinion gears 14. It is considered advantageous that certain of the motors, such as the motors 35, be reversed, so as to operate as pumps, in order to maintain a sufficient back pressure downstream of the die 22 to clamp the gripping element quadrants 13 of each train together along the X direction so as to prevent leakage of the wax 66 between the quadrants. Such reversal of the motors 35 may conveniently involve interconnecting the reversed motors 35 with certain of the motors 31, 32, 33 or 34, such that the reversed motors 35 will serve to drive, or assist in the driving of, the associated motors 31, 32, 33 or 34.

The four trains of gripping element quadrants 13 are advanced along the endless paths 16 by the rotating pinion gears 14, with the gripping elements 21 which surround the waxed rod 11 tending to grip and pull the waxed rod along with their advance in the X direction. The gripping elements are guided during such advance by the interaction between the guide elements 48 and the walls of the apertures 47. The rate of travel of the various trains of gripping element quadrants 13 through the block 26 is maintained uniform due to the keying action provided by each pinion gear 14 acting on the teeth 46 along the adjacent outer peripheries of two neighbouring gripping element quadrants. Thus, any tendency for one of the quadrants to lag the others within the aperture 27 in the block 26 is avoided.

As each new element of the rod 11 advances in the X direction to the entrance end of the apparatus 10, it first encounters the scraper 67 (FIG. 7) in entering the sizing and waxing assembly 19. The scraper serves to remove surface material, such as dust and dirt, from the advancing rod element. The rod element then acquires an initial wax coating in the small entry chamber 71, incurs an initial reduction in size in passing through the sizing die 63, is rewaxed in the waxing chamber 64, and finally has its wax coating reduced to a desired thickness by the wiper 68 as the rod element exits from the sizing and waxing assembly 19 and enters the central aperture 27 in the block 26. The size and configuration of the waxed element of the rod 11 now correspond closely to the size and configuration of the central aperture 44 which extends in the X direction through the centre of the converged gripping elements 21.

The element of the rod 11 next advances into the region where the four trains of grip-

ping element quadrants 13 converge. A set of four advancing quadrants comes together to form a gripping element 21 surrounding the waxed rod element. The four belts 59, meanwhile, contact the bases 43 of the four gripping element quadrants 13 which form the gripping element 21, advancing by virtue of frictional contact with the quadrants, and serving to transmit gripping pressure to the quadrants from the four stationary pressure pads 51. Shear forces in the X direction are transmitted to the rod element to cause the rod element to continue to advance with the gripping element toward the die 22. At the same time, radial compressive forces applied by the gripping element quadrants 13 increase with X direction movement of the gripping elements due to the increasing fluid pressure level maintained within each successive passageway 62 and each successive inner seal 57 of the seal assemblies 54 on the pressure pads 51. Thus, the pressure applied through the wax coating on the rod element builds up to a sufficient level upstream of the die 22 to increase the ductility of the rod element substantially, whereupon the rod element is caused to pass through the die 22 and is hydrostatically extruded into an element of the wire 12. The gripping element 21 associated with the wire element so produced continues to advance about the advancing wire element to a location somewhat downstream of the die 22. At this point, the four component gripping element quadrants 13 diverge, each to follow its own endless path 16 back toward the entrance end of the apparatus 10, and there to recombine with the other three quadrants to receive an additional element of the advancing rod 11.

It is to be understood that the described apparatus and methods are simply illustrative of a preferred embodiment of the invention. It should be clear that various other embodiments might also be utilized for extruding or otherwise deforming rod or any other elongated workpiece of circular or other cross section in accordance with the principles of the invention. For example, alternative embodiments might incorporate fewer or more than four trains of gripping element members which travel about endless paths and which cooperate to form gripping elements for advancing an elongated workpiece of indefinite length to be deformed into an elongated product of indefinite length. Many other modifications might also be made within the scope of the invention.

WHAT WE CLAIM IS:—

1. Apparatus for continuously deforming an elongated workpiece to produce an elongated product comprising a deforming means, a plurality of trains of gripping element members each arranged to move in an endless path, and means for driving them around



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said paths the paths being arranged so that members of each train come together at a first station to form a gripping element and continue together to a second station, the deforming means being located between the first and second stations, the inner surfaces of the gripping element members defining between them a central chamber in said gripping elements between said first and second stations for containing the workpiece, a plurality of endless belts each associated with a different one of the trains of gripping element members and arranged to advance in contact with the outer surface of its associated member from the first station to the second station and means for applying pressure through the belts to the gripping element members to produce stress in a workpiece within the said chamber so that the moving elements continuously advance the workpiece and force the workpiece into contact with the deforming means.

2. Method of continuously deforming an elongated workpiece to produce an elongated product comprising driving a plurality of trains of gripping element members along endless paths so arranged that a gripping element member from each train come together at a first station to form a gripping element and continue together to a second station, an inner surface of each of the gripping element members defining between them a chamber running between the first and second stations, advancing an endless belt in contact with an outer surface of each of the gripping element members of a train between the first and second stations, applying pressure through the associated belt to each gripping element member between the first and second stations so as to force the members towards each other and thus apply stress to a workpiece contained within the chamber, whereby the workpiece is gripped and continuously advanced against a deforming means located within the chamber between the first and second stations to produce the elongated product.

3. Apparatus according to claim 1 wherein the means for driving the trains of gripping element members comprising means for simultaneously engaging gripping element members in each pair of adjacent trains for moving the pair in unison, so that all the members of the trains move in unison.

4. Apparatus according to claim 1 or 3 including bar means extending at least part of the way between the first and second stations for simultaneously engaging the surfaces of apertures in at least two adjacent gripping element members for guiding them during movement between the stations.

5. Apparatus according to claim 3 or claim 4 with claim 3 wherein the driving means comprises toothed wheel means for engaging adjacent sets of teeth on adjacent gripping

element members so as to drive them in unison.

6. Apparatus according to claim 1, 3, 4 or 5 wherein the pressure applying means is arranged to produce a pressure gradient such that the pressure increases from the first to the second station.

7. Apparatus according to claim 1, 3, 4, 5 or 6 wherein the pressure applying means comprises a plurality of passages communicating with the surface of each of the belts opposite to the surfaces in contact with the gripping element members, for applying pressurised fluid to the belt surfaces at spaced locations, each passageway being surrounded by a pressure seal in contact with the belt surface to prevent escape of fluid.

8. Apparatus according to claim 7 wherein the seals comprise at least one inner seal surrounded by an outer seal.

9. Apparatus according to claim 8 with claim 6 wherein an outer seal surrounds a plurality of inner seals, the passageways terminating in the inner seals being adapted to supply fluid at different pressures.

10. Apparatus according to any one of claims 7 to 9 wherein the passageways are formed in pressure pads which also contain passageways for the circulation of cooling fluid.

11. Method according to claim 1 including driving the gripping element members by means common to two adjacent members.

12. Method according to claim 11 including driving two adjacent gripping element members by means of a toothed wheel engaging adjacent sets of teeth on the two members.

13. Method according to claim 2, 11 or 12 including guiding the gripping element members for at least part of the way between the first and second stations by bar means engaging the surfaces of adjoining apertures in two adjacent members.

14. Method according to claim 2, 11 12 or 13 including applying pressure to the belts by means of pressurised fluid applied through passageways to portions of the surfaces of the belts opposite to those engaging the gripping element members.

15. Method according to claim 14 including increasing the belt pressure in the direction of travel of the belt so that the stress on the workpiece is increased towards the point of deformation.

16. Method according to claim 15 including sealing each of the regions around the passageway exits and also providing a seal around the individual seals.

17. Method according to claim 14, 15 or 16 including applying pressure such that the workpiece at least in the region of deformation exhibits increased ductility.

18. Apparatus according to any one of claims 1 or 3 to 10 wherein the deforming means is an extrusion die.



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19. Apparatus according to claim 18 wherein the workpiece is a rod and the product is a wire.
- 5 20. Method according to any one of claims 2 or 11 to 17 wherein the deformation of the workpiece consists of extrusion through a die.
- 10 21. Method according to claim 20 wherein a rod forms the workpiece which is extruded to form wire.
22. Wire when produced by the method of any one of claims 2 or 11 to 17 or 20 or 21.
23. Apparatus arranged and adapted to operate substantially as herein described and as shown in FIGS. 1 to 10 or FIGS. 1 to 7 and 11 of the drawings. 15
24. A method of continuously deforming an elongated workpiece to provide an elongated product substantially as herein described. 20
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